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BURNGRANGE

NOS. 1 AND 2 (Oil Shale) MINE, MIDLOTHIAN

REPORT

On the Causes of, and Circumstances attending,
the Explosion and Fire which occurred on the
10th January, 1947, at the Burngrange
Nos. 1 and 2 (Oil Shale) Mine, Midlothian

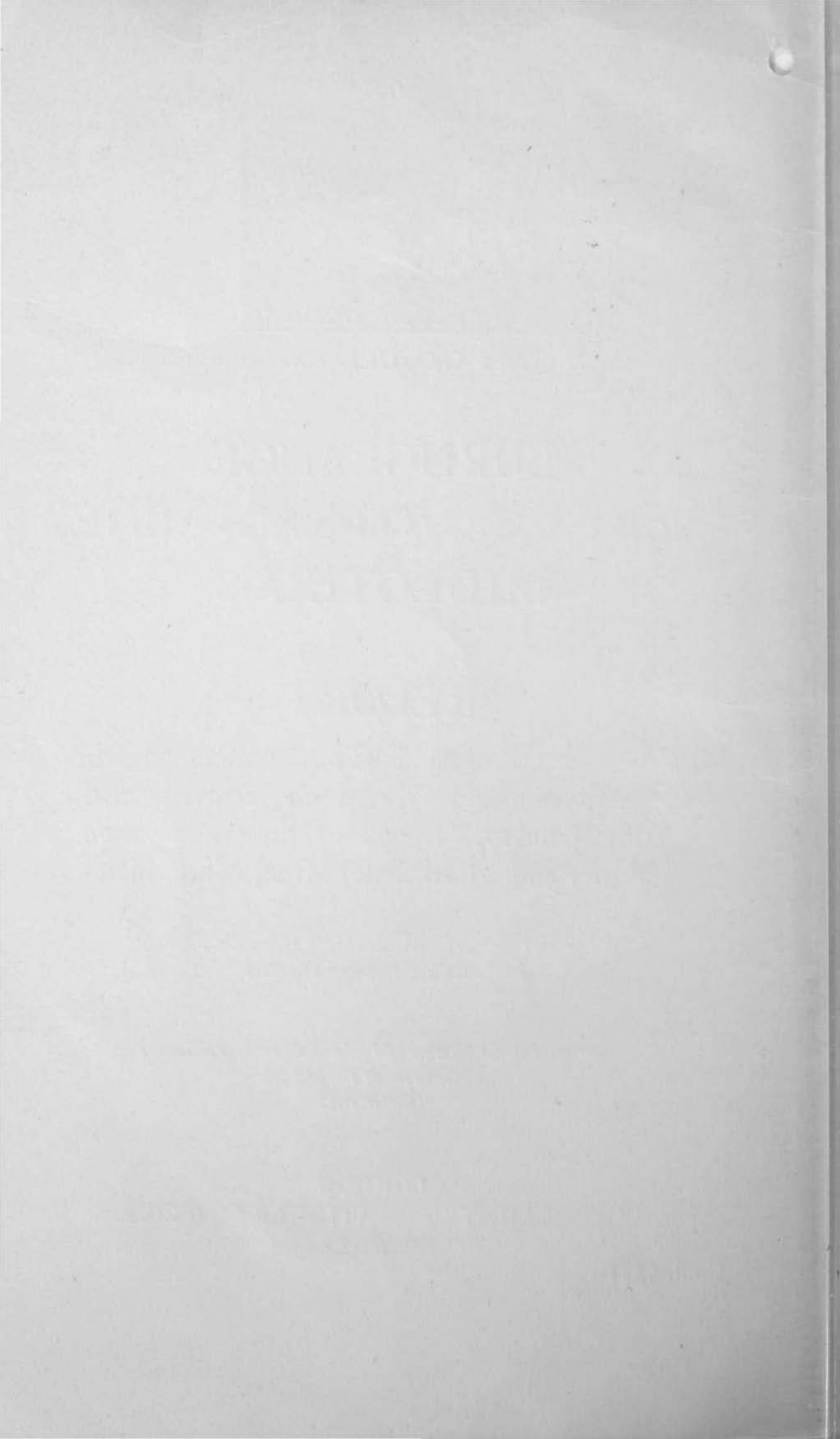
By A. M. BRYAN, J.P., B.Sc.
H.M. Chief Inspector of Mines

*Presented by the Minister of Fuel and Power to Parliament
by Command of His Majesty
October 1947*

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REPORT

On the Causes of, and Circumstances attending, the Explosion and Fire which occurred at Burngrange Nos. 1 and 2 (Oil Shale) Mine, Midlothian, on the 10th January, 1947

TO THE RIGHT HONOURABLE EMANUEL SHINWELL, M.P.,
Minister

15 September, 1947.

SIR,

EXPLOSION AND FIRE AT BURNGRANGE Nos. 1 AND 2 (Oil Shale) MINE, MIDLOTHIAN

In compliance with your direction, I have held a formal Investigation under the provisions of Section 83 of the Coal Mines Act, 1911, and under the Ministry of Fuel and Power Act, 1945, into the causes of, and circumstances attending, the explosion and fire at the Burngrange Nos. 1 and 2 (Oil Shale) Mine, Midlothian, on 10th January, 1947. I have now the honour to submit the following Report.

1. The Inquiry commenced in the Seafeld Institute, West Calder, at 10.30 a.m. on Tuesday, 25th March, 1947, and was concluded on Wednesday, 26th March. A list of the thirty-one witnesses examined in the course of the proceedings is given in Appendix I.

PARTIES AND THEIR REPRESENTATIVES

2. The parties who appeared at the Inquiry and the names of the representatives are set out below :—

Mr. A. H. Steele, H.M. Divisional Inspector of Mines.	}	The Ministry of Fuel and Power.
Mr. T. A. Rogers, H.M. District Inspector of Mines.		
Mr. Robert Crichton, Managing Director.	}	Young's Paraffin Light & Mineral Oil Co., Ltd.
Mr. John M. Caldwell, General Mines Manager.		
Mr. Walter Nellies, M.B.E., J.P., General Secretary.	}	National Union of Shale Miners and Oil Workers.
Mr. James McKelvie, Organiser.		

SITUATION AND OWNERSHIP OF MINE

3. Burngrange Shale Mine is situated about 16 miles south-west of Edinburgh in the Parish of West Calder in the County of Midlothian. It is owned by Young's Paraffin Light & Mineral Oil Co., Ltd., which is a subsidiary of Scottish Oils, Ltd., and is one of a group of 12 mines working the oil shales in the Counties of Midlothian and West Lothian.

BRIEF DESCRIPTION OF MINE AND METHOD OF WORKING

4. The Burngrange mine is relatively new, having started production in 1936. There are two vertical shafts, each 14 ft. in diameter and brick lined throughout. No. 1 shaft is used for winding men, minerals and other materials. No. 2 shaft is used for ventilation and pumping. Both shafts are sunk to a depth of 468 ft. to work the Dunnet Shale Seam, which varies in thickness from 9 to 12 ft. The dip of the seam in the No. 2 district of the mine is variable, averaging 1 in 5 in a north-westerly direction. The mine is ventilated by a double inlet Sirocco exhausting fan passing about 100,000 cubic feet of air per minute at a water gauge of 0.95 in. All workings are in the Dunnet Shale Seam. The average daily output of shale over two winding shifts is 600 tons. The number of persons employed is approximately 29 on the surface and 176 underground, giving a total of 205 persons.

5. The method of working is stoop and room. The size of the stoops varies according to the depth, but in the area affected by the explosion, the stoops are formed approximately 150 ft. by 110 ft. by driving rooms 12 ft. wide and 9 ft. high on level course and at right angles thereto. Where the seam exceeds 9 ft. in height, the top shale is left to form a roof. In the second working, when the stoops are being extracted, splits are first driven through each stoop to form small pillars which are then extracted by taking off lifts 12 ft. wide and the full height of the seam. Pillar extraction is generally arranged so as to form and maintain a main roof-fracture line at an angle of about 45° to the levels.

6. Plan No. 1 shows the lay-out and full extent of the underground workings, the general direction of the ventilation and the quantities of air passing in each ventilating split. The disaster was confined to one ventilating split which ventilated part of No. 3 District and the whole of No. 2 District. The latter District comprises two sections of workings, one in which the pillars were being extracted and one to the east of it where the large stoops were being split into small pillars. From Plan No. 1 it will be seen that an area of fully three acres of shale has been completely extracted to the north-east of a middle dook which, although sometimes known as the 40 H.P. dook, will be referred to hereinafter as No. 2 dook. Extraction of the stoops in this area commenced in November, 1945, and was being continued on the west side of the area. From the inbye ends of Nos. 10 to 14 Levels—see Plan No. 1—and to the east of the stooped area, the stoops were being split into pillars. These pillars were to be left to avoid subsidence and damage to a housing scheme on the surface. It was in this section of the workings that all but one of the 15 victims of the disaster lost their lives. Preparatory splitting of stoops prior to extraction was also proceeding in the No. 3 District on the outbye or west side of the extraction area.

7. The shale is got by blasting, and is hand-filled by the miners into 20-cwt. capacity hutches which are hand drawn for relatively short distances by drawers to a subsidiary mechanical haulage. Thereafter, the hutches are hauled by Diesel locomotive and main rope haulage to the shaft bottom. The explosive used is compressed gunpowder fired by fuse. The holes for blasting are bored by electrically operated drilling machines. All underground machinery is electrically operated.

8. A mixed system of lighting, comprising open lights and safety lamps, is in use underground. Although firedamp was of rare occurrence, its presence was not unknown and, in consequence, certain precautions were taken. It was customary for the miner at the working face to use an approved electric safety cap lamp and to be provided with an approved flame safety lamp

which was hung up near the working face. The drawers, who carried these flame safety lamps in and out of the mine, and the other outbye workmen used open acetylene cap lamps. Rules posted at the mine regarding the use of safety lamps were as follows :—

“ FACEMEN IN CHARGE OF PLACES SHALL USE ELECTRIC CAP LAMPS.

FLAME SAFETY LAMPS SHALL BE KEPT IN WORKING PLACES.

BEFORE ENTERING PLACES AT THE COMMENCEMENT OF WORK AND BEFORE AND AFTER SHOT-FIRING, THE FACEMEN SHALL TEST FOR THE PRESENCE OF GAS.”

MANAGEMENT OF THE MINE

9. The mine, being a mine under the Coal Mines Act, 1911, was under the daily supervision of a certificated manager, Mr. John Brownlie McArthur, who was assisted by a certificated under-manager, Mr. Archibald Gibb Russell. Supervising them was Mr. John Stein, the Agent, who in turn came under the direction of Mr. John Caldwell and Mr. Robert Crichton, General Mines Manager and Managing Director, respectively, of Scottish Oils, Ltd., all holders of first class certificates of competency in mine management and all of whom, to a greater or lesser degree, took part in the technical management of the mine.

THE EXPLOSION AND SUBSEQUENT FIRES—GENERAL OBSERVATIONS

10. The explosion occurred about 8 p.m. in the sixth hour of the afternoon shift on Friday, 10th January, 1947, when 76 persons were at work underground. It originated at the face of the rise split off No. 14 Level, one of James Todd's working places in the No. 2 District, when firedamp was ignited at an open acetylene cap lamp. Fifty-three persons were employed in the district at the time. One man, John McGarty, who was blown down by the force of the explosion, received injuries from which he died a few minutes later. The initial explosion started fires which spread to various parts of the district and, subsequently, 14 men employed in the section of narrow workings on the return side of the extraction area, lost their lives by the effect of the after-damp and fumes from the initial explosion and the subsequent fires. A list of the victims of the disaster, with their ages and occupations, together with the nature of the injuries sustained, as prepared by Dr. W. C. Sharp, H.M. Mines Medical Officer for the Scottish Division, is given in Appendix II.

11. A disaster of this magnitude is unique in shale mining and for this reason a short note on the background of the Industry may prove useful. Oil shale has been worked in the neighbourhood since 1858, and on a scale so extensive that by 1865 there were no less than 120 works processing the oil shales of the Lothians or cannel shales of the coal measures. The oil shales of the Lothians occur in the Calciferous Sandstone Series near the base of the Carboniferous System and constitute a local development peculiar to West Lothian, Midlothian and adjacent portions of the Counties of Fife and Lanark. The annual output of shale from mines owned by six different operating companies reached a maximum of approximately three and a quarter million tons in 1913. All the different owning companies were brought under one management in 1919 by the formation of Scottish Oils, Ltd. For many reasons, since 1913, mainly arising from the wars of 1914–18 and 1939–45, there have been considerable fluctuation and decline in the annual output which, for the year 1946, was just over one and a third million tons.

NARRATIVE OF THE EXPLOSION, FIRES AND RECOVERY OPERATIONS

12. About 8 p.m. on the night of Friday, 10th January, during the ordinary course of work on the afternoon shift, three men, James Todd, Thomas Reid and John McGarty, were at work in two adjoining stooping places—No. 14 Level face and a rise split a short distance out-by from the face of 14 Level—in the stooping section in the No. 2 District. Todd, who was an experienced shale miner, was the faceman in charge of these two places; Reid and McGarty were his drawers. In accordance with the custom of the mine, Todd used an electric safety cap lamp and Reid an open acetylene cap lamp, but McGarty, contrary to custom, used an electric safety cap lamp. In addition, however, each drawer carried a flame safety lamp, one for use in each of the two working places, which was suspended near the face while work was in progress. In accordance with the rules of the mine, these safety lamps were used by Todd, who had received instruction in gas testing, to examine the places for gas prior to the commencement of work and also prior to and following shot-firing. The three men had worked in the two places that afternoon from about 3.30 p.m. until about 7 p.m. when they went outbye to eat some food, taking with them the two flame safety lamps. There was no shot-firing in these places that afternoon. About 8 p.m. the three men returned to the working places, Todd and Reid to the rise split and McGarty to the face of No. 14 Level. Todd “wearing” his electric cap lamp and carrying a flame safety lamp in his hand, went first to examine for gas at the face of the rise split, while Reid, his drawer, remained at the entrance to the split to clear some fallen shale which Todd had pulled down on his way out at meal time. It appears that, during the meal interval, the roof in the split to the rise had been “weighting” heavily and had broken most of the timber props set to support the roof. The appearance of the place on his return was such a surprise to Todd that, most unfortunately as it turned out, before actually examining it for gas, he called Reid up to see it. When Reid had reached a point about 5 yds. from the face, his open acetylene cap lamp ignited gas near the roof. The ignition was accompanied by a rumbling noise and the flame travelled towards the waste. Todd shouted to Reid and McGarty to clear out. Todd and Reid had just commenced to run outbye when a second report was heard and they were more or less blown down the split, a distance of about 15 ft., and slightly stunned. When they had sufficiently recovered they called for McGarty; they got no response but heard groaning and found him lying unconscious in the middle of No. 14 Level roadway about 40 ft. back from his working face. In rushing out of his working place he had either been knocked off his balance or had been blown down by the force of the explosion and, in falling, had fractured his skull. Todd immediately went outbye for assistance, which was soon forthcoming, as the men from the adjacent places were by this time on their way outbye. A few minutes later a stretcher party came in for McGarty and carried him outbye. He never recovered consciousness and died on the way out.

13. The evidence of the workmen in the adjacent stooping places to the dip and rise side of Todd's working places supported the statements of Todd and Reid that there were at least two mild explosions, the noise of the second being rather louder than that of the first. One workman likened the noise of the first explosion to that of a “well-defined shot”, while the second he described as being “louder and fiercer”. A measure of the degree of violence is given by the physical effects observed in the stooping place immediately to the dip of No. 14 Level. In this place, the concussion or shock from the explosion was sufficient to extinguish the open acetylene lights, dislodge a flame safety lamp suspended by its hook, cause the workmen in the place to lose their

balance, and raise a dense cloud of dust into the atmosphere. The physical effects observed in the place immediately to the rise of Todd's place were similar. In this place, however, a workman saw a "lighting up of the stoops" which he considered to be a reflection from a flame travelling up the waste, while in the next place to the rise, the workmen actually saw a flame passing up the waste and stated that they lay down on the pavement until it passed. The workmen in other stooping places more remote from Todd's, although they did not see flame, experienced similar physical effects to those just described, but to a lesser degree, and so all got warning that something out of the ordinary had occurred which caused them to leave their working places without delay and proceed outbye. They all got out safely and thus McGarty was the only casualty in the stooping section.

14. The story now turns to the happenings in the section to the east and on the return side of the stooped area, where the stoops were being split. The principal evidence relating to this section was given by a 17-year-old benchman, Alexander Todd, who was employed on the No. 3 Dook (see plan). His duties were to detach the empties from the dook haulage at the various benches and despatch the full hutches in rakes or trains of three. Shortly after 8 p.m. he was sitting at the bench at the junction of No. 13 Level with No. 3 Dook, talking to two drawers, Sam Pake and David Muir, who had come out with full hutches ready to take empties back to the face, when he said he felt two "wafts of air", which extinguished their acetylene lights. He felt somewhat frightened. After relighting their lamps, Pake and Muir teased Todd a little and then proceeded towards the face, each taking an empty hutch. Todd stated that, when they left him, they told him they were going in "to tell the boys". It seems clear, however, they did not realise that anything serious had happened—at least nothing that called for a warning of immediate danger to the men inbye. Indeed, later investigations proved that the empties they had taken inbye were filled with shale—operations which would take about 25 minutes. After Pake and Muir left him, Todd coupled the full hutches at the bench and then proceeded to signal for the empty rake or train to be lowered. When it arrived he noticed a lot of smoke coming down with the air. He signalled for the rake to stop at No. 13 Level and, getting into it and putting out his light, he signalled for it to be hauled up again. As he approached the top of the dook, he noticed the dust and smoke in the air were thicker. As soon as the rake stopped at the top of the dook he called to the lad employed at the dook-head and to the haulage engine attendant, and they all immediately went outbye, as they said "to get fresh air" for, by this time, the atmosphere at the top of the No. 3 dook was thick with dust, smoke and fumes. After waiting a little outbye, the engineman and Todd attempted to go inbye again to get their clothes, but they were unable to do so because of the smoke and fumes. This was probably about 8.20 p.m. so that by this time the plight of the inbye men was already very precarious.

15. At this time there were 14 men, including Pake and Muir, in the various working places on the inbye side of No. 3 Dook and it is apparent they did not realise the danger that beset them until it was too late. Not one of them got out alive. Except for Pake and Muir, all of them, in my opinion, were too remote from the site of the explosion to notice anything unusual at the time it happened. Believing, as I do, that neither Pake nor Muir had conveyed any warning that something untoward had occurred, the first warning the inbye men would get would be from the foul condition of the air current as a result of contamination by the after-damp, smoke and dust from the initial explosion and the subsequent fires. And since there is evidence that some short-circuiting of the air current had occurred as a result of the explosion by reason of the disturbance and displacement of brattice screens separating the intake from

the return near the entrance to the inbye section, this warning would not be conveyed to them as strongly or as quickly as it would have been had the screens remained intact and the full ventilation taken its normal course. It is probable too that even when the first signs of fouling in the air current reached them they would not realize the danger, and probably thought it due to the reek of shots that had been fired later than usual somewhere outbye and on the intake side of them. They would certainly not suspect that the atmosphere was fouled by the after-damp of an explosion or by the smoke and fumes from underground fires. By the time they did realize that something unusual and dangerous had occurred, all three ways of exit from the inbye workings—No. 11 Level, No. 10 Level or Diesel Road, and the Return Airway—had become impassable by reason of the deadly smoke-laden atmosphere in them, which must have contained a dangerous proportion of carbon monoxide.

16. There was some speculation as to whether the inbye men would have had time to get out safely had Pake and Muir realized at the time they were last speaking with Alexander Todd that something really serious had happened and had they made it their business to rush into the section and warn the other men to clear out without delay. I believe the majority of the men would have got out alive had they received and responded promptly to an early warning, and it is just possible that all would have succeeded.

17. The first serious attempt to explore the workings on the inbye side of the stooped area where the 15 men were trapped was not made until about 8.35 or 8.40 p.m. It so happened that at the time of the explosion there were no officials in the immediate vicinity. The back-shift fireman, George Crombie, was outbye at the junction of McIntyre's Dook with No. 10 Level on his way home, while the shift overman, David Brown, had gone to the surface for consultations and his meal. About 8.15 or 8.20 p.m. Brown was in the office discussing pit business with the manager, Mr. J. B. McArthur, when a message was received from the winding engineman that "a Doctor and an ambulance were wanted for McGarty and that there had been an explosion". Reference to this message and the significance attached to it by its recipients will be made later. For the present, suffice it to say that, after arranging for a telephone message to be sent to the Doctor to come at once to the colliery and, after collecting some morphia ampoules, the overman and the manager both went down the pit. At this time it was 8.20 p.m.

18. When going down No. 1 or McIntyre's Dook, they were told by one of the outgoing men that an explosion had occurred somewhere in the region of James Todd's place, that a stretcher party was bringing out McGarty, that all the other men in the stooping section were safe, but that he had no information about the men in the inside dook section. The overman, Brown, then handed over his morphia ampoules to the manager and proceeded post haste inbye towards the No. 3 Dook while the manager proceeded to the stooping section. On his way Brown picked up the fireman, Crombie, and both went in by No. 10 Level to explore the position in the narrow workings on the inbye side of the No. 3 Dook. When they got as far as the heading on the outbye side of No. 2 Dook, they encountered smoke coming up from it and still more smoke coming up the No. 2 Dook itself, in the general body of the air. It was not sufficiently dense, however, to prevent Brown and Crombie from going further along No. 10 Level. They managed to get in almost to the top of the No. 3 Dook. In passing the junction of the heading between No. 2 and No. 3 Dook, they encountered still more smoke coming up this heading. At this time they were not affected by heat but, because of the smoke, they had to withdraw to a point just outbye No. 2 dookhead, as they said, "for a breather".

19. After waiting a few minutes, Brown made another attempt, alone, to get inbye. He stated that, on this occasion, he actually got in to the No. 3 dook-head, where he shouted but got no response. Neither did he see any signs of the inbye men nor of their lights, and he was forced to withdraw again. On his way outbye, he again met Crombie, who said he had been trying to improve the atmospheric conditions in the inbye section by a partial opening of some brattice screen doors. But this step was of no avail. The atmospheric conditions were getting worse all the time, due to the spreading of the fires, the extent and seriousness of which were not fully realized at this time. Brown, however, did realize the seriousness of the position in relation to the trapped men and immediately sent word to the manager who was dealing with fires in the stooping section, explaining the position, asking for all possible assistance and making it quite clear that there was no hope of undertaking further exploratory work without the use of rescue teams wearing self-contained breathing apparatus. He then set out to discover for himself where all the smoke was coming from. At this point, it is convenient to leave the story of the attempts to rescue the trapped men and consider the fire position.

20. Although no sign of fire was observed when the stretcher party removed McGarty from No. 14 Level Face, very soon afterwards small fires were discovered in No. 14 Level and in the upset off it, and also at the waste edge in the split off No. 15 Level. At this time the fires seemed relatively unimportant and to be confined to burning timber on the floor. The manager detailed men to fight these fires with the underground fire-fighting equipment at hand, consisting of sand from portable sand boxes placed at the various working levels and portable fire-extinguishers collected from the various motor rooms and other places in the vicinity. But, small as the fires were, with the equipment then available, the men could not do more than keep them in check. It was obvious, too, that the relatively small fires discovered at this early stage could not account for the dense volumes of smoke and fumes that were by this time reaching No. 11 Level just outbye No. 3 Inside Dook. Later, another small fire was discovered at the waste edge in No. 13 Level and a much larger fire in the heading or upset on the inbye side of No. 2 Dook.

21. The manager quickly realized the seriousness of the situation as well as the urgent need for additional fire-fighting appliances and the services of the trained mines rescue brigades. Being satisfied that the fire-fighting services of the mine were in full operation and that everything possible was being done that could be done in the circumstances, he proceeded to the surface to make the necessary arrangements. Urgent calls for full assistance were sent to the National Fire Service and the Mines Rescue Station, key men and trained rescue men were sent for and the necessary materials for fire-fighting and rescue work collected. The National Fire Service received the call at 9.25 p.m. and an officer and four men arrived at the mine from their station eight miles distant at 9.40 p.m. in the mobile fire engine, with fire-fighting equipment, including two Proto one-hour self-contained breathing sets. The Mines Rescue Station Superintendent at Edinburgh received a call at 9.20 p.m. and he and his assistant arrived at the mine in the Mines Rescue Car with all necessary equipment, at 10.30 p.m., where the trained members of the colliery rescue team were awaiting them.

22. Although the National Fire Service was never intended for fire-fighting underground in mines, nevertheless, the team at once volunteered for this duty. Two members of the team donned their one-hour Proto Breathing Apparatus. Underground, they met the overman, Brown, who pleaded for the use of the two sets of Proto Apparatus, so that he and another trained member of the Burngrange Mines Rescue Team—J. McArthur—could make another

attempt to get into the workings beyond No. 3 Dook. After handing over their apparatus, the National Fire Service team were taken into No. 14 Level where they tackled the fire with portable fire extinguishers. Attention had to be directed, however, to the far more serious fire which had been found in the heading beyond No. 2 Dook by a trained mines rescue brigade, now in action. After making the necessary arrangements for a supply of water to the inbye workings and getting their portable pumps and hose brought down the mine, the National Fire Service men commenced fighting this fire under the charge of N.F.S. Superintendent Muir, who had also arrived. Mine officials and trained mines rescue men, under Superintendent Davidson, were in attendance all the time to guide them and keep watch on the condition of the atmosphere and roadways. The other smaller fires were kept under control, but the fighting of this larger fire

it could be brought under control, rescue operations beyond it were impossible. At one time as much as 600 gallons of water per minute were played on it.

23. In the meantime, Brown and McArthur, using the one-hour Proto sets borrowed from the N.F.S., had made an unsuccessful attempt to reach the trapped men. This sortie enabled them to give some details of the position when the full mines rescue brigade came into action under the direction of Superintendent Davidson. The first team, designated "Oils No. 5 Brigade", descended the mine ready for action at 10.30 p.m., accompanied by Superintendent Davidson, his assistant R. McIntosh and Mr. John Caldwell, the General Mines Manager, who had just arrived at the mine. Instructions were left for the "Oils No. 4 Brigade" to dress and follow on. Underground, a fresh air base was established at McIntyre's Dook, where the stretchers, revivers and birds were left under the care of Davidson and McIntyre. At 11.15 p.m., under the captaincy of the indefatigable overman, Brown, Oils No. 5 Brigade, wearing goggles and using a life-line, set off with instructions to explore No. 10 Level and try to make contact with the trapped men. Sweating profusely, the brigade returned at 11.30 p.m. with a report that the temperature was very high and the smoke so dense that they could not see each other's lights. Nevertheless, the brigade insisted on trying again. The fresh-air base was moved forward 172 yards and the team once more set off. On returning, they reported having reached a point near the No. 3 Dook, where they encountered a fall of stone and bad roof conditions. They also heard signs of strata movement and "weighting" and stated that they could not examine the conditions because of the thick smoke in the atmosphere. The brigade then attempted to reach the men by way of No. 11 Level but found this impossible because of a serious fire burning at the junction of the first heading beyond No. 2 Dook. Following the discovery of this fire and the report on the atmospheric conditions by the rescue brigade, it was clear to all that there was no hope of reaching the trapped men until this fire was under control. All efforts were now concentrated in getting the maximum fire-fighting power into action. It was decided that this work could be undertaken by the National Fire Service men without breathing apparatus, so long as they were accompanied by a trained mines rescue brigade, provided with oil flame safety lamps and birds, to keep watch on the atmospheric conditions and on the conditions of the roof and sides of the roadways.

24. The work of fire-fighting continued without abatement and it was not until four days later, on the night of the 13/14th January that it was considered practicable to send a rescue team to explore beyond the fire area. On this night the Oils No. 2 Brigade went in and came back with a report that they had found the bodies of eight men lying By this time the atmosphere was much clearer and the temperature only a little above normal. Thereafter, the district was quickly explored and all the bodies

located and recovered. The positions in which the 14 bodies were found are shown on Plan No. 2, which also shows the normal working places of all the deceased men. It will be seen that, with the exception of one body, that of G. Easton, all the bodies were found in No. 3 Dook. There was evidence to show that Easton had attempted to brattice off the face of No. 13 Level, the place where his body was found, in an attempt to shield himself from the noxious atmosphere. A study of the details shown on Plan No. 2, such as articles of clothing, lamps, tools, etc., also indicates quite clearly that the victims, when they did try to escape, had tried several alternative routes.

25. From Appendix II it will be seen that of the 15 victims of the disaster only two sustained burns. They were W. Findlay and W. Ritchie. Although burned, they nevertheless died from the same cause as the other trapped men, viz. the effects of carbon monoxide as a result of breathing the afterdamp. It is, however, somewhat strange that they should be the only two persons to sustain burns and also difficult to explain.

26. Plan No. 2 shows their places of work prior to the occurrence and also the situations in which their bodies were found. No one can say, of course, whether or not they were in fact actually in their working places at the time of the explosion, but if they were it is difficult to believe that they could be burned without the persons working alongside them also being burned. Moreover, there was no evidence of the passage of flame or hot gases in either of their working places. It would appear then that they were not burned in their place of work.

27. There may be some significance in the situations in which their bodies were subsequently found. Findlay was at the lower end of the row of bodies on the No. 3 Dook, while Ritchie was at the other. It may be that both men had attempted to find a way out, Findlay by No. 10 Level and Ritchie by No. 11 Level, and that both were caught by fire, hot gases or even a slight inflammation of firedamp. Fortunately, the matter is not important so far as the ascertainment of the cause of this disaster is concerned.

28. It will also be recalled that when Pake and Muir left the bench at the junction of No. 13 Level with No. 3 Dook, at the time of the explosion, they each took inbye an empty hutch. When No. 13 Level was explored, there were no empty hutches at the face but two full hutches were found on the level. It was given in evidence by several witnesses that to draw and fill these two hutches would take not less than 25 minutes, indicating that, during this period, the atmospheric conditions inbye were not such as would indicate serious or immediate danger. This confirms the view that Pake and Muir had either not appreciated the significance or potential danger of the unusual happening which occurred at the actual time of the explosion and which caused their lights to be extinguished and Todd to be frightened or, if they did, they had been unable to convince the men inbye that there was something so seriously wrong as to warrant instant withdrawal. As previously indicated, my opinion is that they did not realize the position and that they did not give any warning. Nor do I think them blameworthy in any degree. Older and more experienced men failed to realize the immediate danger, and, as will be seen, even the management did not believe at first that it was possible for an explosion to have occurred. Nevertheless, it would appear that had the inbye men received and heeded an immediate warning they might have all been alive to-day.

29. The exploration also revealed evidence of intense heat in the upset leading from the waste edge at No. 12 Level across Nos. 11 and 10 Levels and thence past the 29 H.P. hauler in the direction of the return airway. It will

be remembered that it was in this upset that the most serious fire occurred and from which the greatest volumes of smoke and fumes had come. The heat undoubtedly damaged the brattice screens in this upset and thus led to some direct short-circuiting of the poisonous and smoke and dust-laden atmosphere from the explosion and fire area to the return airway. In this way the warning to the inbye men would be delayed and the return airway would be fouled by a poisonous atmosphere in the early stages of the disaster and thus a most likely means of egress for the victims cut off.

COMMENTS

ON THE FIRST WARNING OF THE EXPLOSION AND THE FAILURE TO APPRECIATE ITS SIGNIFICANCE

30. The explosion occurred about 8 p.m. and the first message concerning it was telephoned to the surface about 8.20 p.m. The winding engineman who received it transmitted it at once to the manager, who was then discussing mine business with the overman, David Brown. The message was that "a doctor and an ambulance were wanted for McGarty, and that there had been an explosion". The manager's immediate reactions, in his own words were :—

"I gave the message thought and I considered the word 'explosion' was wrong. I could not conceive of an explosion in McGarty's place, but I could conceive of a severe fall of roof giving a report like an explosion. On the other hand, had the word 'explosion' been right, I could not conceive of a big explosion being there".

31. It is clear that the manager, from his long experience in oil-shale mining, thought that there might possibly have been a small ignition of gas but thought it more likely that there had been a heavy fall of roof. He certainly could not, at the time, bring himself to believe that an explosion of a serious nature had occurred. And in this view he was not alone. Consequently, it never occurred to him or to the overman, to call for the services of the Mines Rescue Station. He did, however, send for the doctor before he and the overman went down the mine to investigate what had happened.

32. The significant point is that, had the manager realized there had been a serious explosion, he would have called for the services of the Mines Rescue Station at least one hour and ten minutes earlier than he, in fact, did, and the question arises as to whether lives would have been saved had the trained brigades been in action 70 minutes sooner than they were. This means that the first fully equipped team, wearing self-contained breathing apparatus, would have left the fresh-air base at 10.5 p.m. and been at the top of No. 3 Dook or its vicinity about 10.15 p.m. By this time, the overman, Brown, had already made at least three, if not four, unsuccessful attempts to reach the men. On his first attempt at about 8.40 p.m. he was affected by the smoke and had to retire "for a breather". The conditions got worse as time went on. After careful consideration of all the circumstances, I am of the opinion that, had the rescue brigades been on the scene even at 10 p.m. they would still have been too late to rescue any of the trapped men alive, and I must conclude, therefore, that the initial failure by the manager to realize the full significance of the first warning did not affect the loss of life involved in this disaster.

33. Although I can understand the reason why the manager, as well as many others, had difficulty in believing the message to be true, nevertheless I consider that, if there is any doubt at all, it is better to err on the safe side.

To have called for the services of the Rescue Station could have done no harm. As Mr. T. A. Rogers said at the Inquiry, in reply to a question put by me : " It is far better to send for a Rescue Brigade a dozen times and not use it than not to send once when it is really needed ".

ON THE PRACTICE OF STOOPING IN THE CENTRE OF A VENTILATING DISTRICT

34. It was suggested at the Inquiry by Mr. Nellies, representing the National Union of Shale Miners and Oil Workers, that it was not in accordance with good mining practice to commence stooping in the middle of a ventilating district and that steps should be taken to avoid it in future. Accordingly, during the course of the Inquiry, Mr. Nellies, quite rightly, closely examined several of the witnesses on the official and management side on this point. It will be seen from Plan No. 1 that the air current in the ventilation split concerned, first traversed some " whole " workings, then coursed the workings in the stooping section and thereafter ventilated the working places in the narrow workings to the east of No. 3 Dook—the section where the men were trapped—before finally passing to the return airway. It is highly probable that in the circumstances of this particular case the death roll would have been confined to one person, McGarty, had the stooping section been at the return end of the district.

35. Although it is more or less the general practice, both in oil shale and coal mining, to commence stooping at the return end of a ventilation split, the stooping of areas otherwise than at the return end is by no means rare or even unusual in the long history of oil shale mining, nor indeed of coal mining. For example, it is normal practice in some coal mines and especially in mines relatively free from inflammable gas, to extract pillars in one panel simultaneously with the opening out inbye of the next panel to be stooped. It so happens that in this Burngrange case, the stooping would almost certainly have been at the return end of the ventilation split had it not been considered necessary, for the purposes of support of property on the surface, to leave small pillars in the area on the return side of the stooping section. After all, Burngrange was a mine considered to be relatively free from inflammable gas, where naked lights were in use, and where prior to this explosion, there was nothing, in my opinion, which would lead the management or anyone else to anticipate any special or increased danger from the method of working or the system of ventilation in use at the time of the disaster.

36. The occurrence does, however, clearly indicate the greater possibility of a major explosion in workings alongside a goaf area compared with " whole " or pillar workings which, in the physical conditions obtaining at Burngrange, normally remain open and accessible for the purposes of examination and ventilation. The suggestion was made that the practice of stooping in the centre of a ventilation split should be prohibited by law, but I am unable to subscribe to this view because of the variation in circumstances, and I am in agreement with the views expressed in evidence by Mr. J. Stein, the Agent, under examination by Mr. Nellies and Mr. Crichton :—

Examination by Mr. Nellies

Q. Now that the dangers have presented themselves, you will agree that there ought to be some modification or supplementation of the Regulations covering stooping in such circumstances ?

A. All future stooping has got to receive special consideration in the light of what has happened here.

Examination by Mr. Crichton

Q. I don't think you can lay down any special regulations in connexion with stooping? I am afraid that every section would need to be considered on its merits?

A. Yes.

Q. And I don't think that, due to this occurrence, you can lay down any hard and fast rule?

A. That is what I think.

Q. And when this plan was arranged for—when we agreed to start stooping here—I think we were all quite satisfied that it was perfectly safe, or it would never have been started?

A. That is so.

Q. And therefore the matter could not possibly receive more consideration than in any other stooping area?

A. That is so.

ON THE OCCURRENCE OF INFLAMMABLE GAS (FIREDAMP)

37. As already indicated, although the mine was relatively free from inflammable gas, the presence of gas was not unknown and certain precautions were taken to safeguard against danger from it. An examination of the records shows that firedamp had been reported on 11 occasions during the year 1946. In all cases the gas was found in small quantity and in nearly every case at the face of rise headings in the solid or "whole" workings. It was readily cleared in a few minutes by the ventilation, following the erection or extension of brattice. Contrary to what one might have expected, inflammable gas has never been detected in any of the stooping places or at the edge of the adjoining goaf or waste.

38. Firedamp is given off to some extent in almost every mine, and because of this, Section 29 of the Coal Mines Act, 1911 (which applies to Oil Shale Mines), contains stringent requirements regarding the amount of ventilation to be provided. In this case there was no evidence of the ventilation, prior to the explosion, having been at any time inadequate within the meaning of this Section.

39. It is obvious, however, that when the initial explosion occurred, there must have been an accumulation of inflammable gas in the unventilated and inaccessible waste, which covered an area of about three acres adjoining the stooping places. There may be difference of opinion as to where this gas came from but the point is relatively unimportant. It may have come up through breaks in the five fathoms of strata between the seam being worked and a seam below, about 2 ft. thick, which had been proved by bore hole. There is, however, no need to postulate such an origin, as the firedamp may easily have been given off steadily over a relatively long period of time by small feeders from the Dunnet Seam itself or from the strata immediately associated with it.

40. This accumulation of firedamp, whatever its origin, was normally in the higher cavities within the waste area, but its presence was not detected at the waste edge. So long as it was thus confined, the gas would not present any danger. How, then, did it come to be expelled and thus create a danger? Firedamp in quantity can exude from a waste when there is a fall in barometric pressure or it can be forced out suddenly by roof movements in the waste and particularly by a heavy fall. Whilst there was a falling barometer at the time,

I think in this case the gas was suddenly expelled by a heavy fall in the waste shortly before the initial explosion. There was evidence of crush in James Todd's working place before the mealtime interval on the afternoon of the explosion and evidence of excessive crush after the meal-time when Todd and Reid returned to work. In other words, the conditions at the time were such as were likely to lead to falls in the waste. That the gas must have been expelled quickly is apparent from the evidence that a naked light was used within a few minutes of the explosion at the face of the split near the waste edge immediately above and to the rise side of James Todd's working place. I conclude, therefore, that the inflammable gas present in Todd's place when Reid and Todd returned to work after meal-time, about 8 p.m. on the night of the explosion, was part of a larger body of gas expelled from the waste by a fall which occurred in the waste towards the end of the meal-time interval.

ON THE CAUSE OF THE EXPLOSION AND ITS DEVELOPMENT

41. There is no mystery as to the cause of this explosion. It was entirely one of firedamp. The question as to whether or not coal dust played a part does not arise in a shale mine. The firedamp was, in fact, seen to be ignited at the acetylene cap lamp of Thomas Reid. The working place was about 9 ft. high and with Reid standing his full height, it is clear that a layer of gas was inflammable at a height of not less than 3 ft. from the roof. It is probable that at the point of ignition the firedamp-air mixture was just a little below the upper limit of inflammability. Again, judging by the lack of violence and the fact that neither Reid nor Todd was burned, it was probably little more than a "trail" of gas of similar composition until the flame reached the fringe of the larger accumulation in the waste when it produced what seemed, in effect, to be a second explosion. Because the inflammable mixture was now more extensive, rather than more explosive, the report of this second explosion was louder and produced greater physical effects, as is shown by the fact that Todd and Reid were blown off their feet, while McGarty, in the place lower down, was knocked off his balance (as a result of the blast) and fatally injured, probably by his head violently striking a rigid, sharp object such as shale on the side of the roadway.

42. The initial explosion must have been relatively small, as none of the three men in its immediate vicinity was burned. The second and larger explosion seems to have extended over a wider area mainly confined to the waste or waste edge. It is highly probable that this was followed by a series of relatively light explosions or "pops" around the waste edge, due to the expansion of gases during the explosions and subsequent contraction, which would result in constituting a series of weakly inflammable mixtures. The evidence points to relatively slow burning as distinct from sharp explosive mixtures and suggests that flame persisted for some time, otherwise it is difficult to account for the more or less simultaneous occurrence of the subsequent fires in several places adjacent to the edge of the waste.

ON THE DEVELOPMENT OF THE FIRES

43. The occurrence of the fires presents unusual features. There seems little doubt that in this case flame had continued long enough or recurred frequently enough to ignite dry timbers at the waste edge and that the pieces of burning timber ignited fallen shale. The roadways were not heavily timbered but the roadway containing most timber was probably the first upset from No. 10 to No. 11 Levels on the inbye side of No. 2 Dook. It will be remembered that it was here the largest fire occurred. This fire probably originated at the waste edge but by the time it was discovered all the timber in this roadway had probably been burned, thus allowing the 3 ft. of oil shale which formed the

immediate roof to fall. There was evidence to show that this roof shale had collapsed in thin slabs which stood on edge and thus presented easier conditions for being set alight. In one part of this roadway near the junction with No. 11 Level, which had to be recovered to allow of rescue operations, no less than 160 cubic yards of shale were burned to ash and the adjacent sides of the solid shale pillars had been set alight.

44. Fortunately, the provision of fire-fighting materials and appliances and the arrangements for using these effectively, as required by the Coal Mines General Regulations of 8th August, 1938, were made, while it is apparent from the evidence that effective arrangements had been made to ensure the assistance not only of the general fire-fighting services of Scottish Oils Ltd., but also to ensure the assistance and services of the National Fire Service organization. Nevertheless there is room for a first-class common fire-fighting service for mines of all classes, whether operated by the National Coal Board or not, based on or co-ordinated with the Mines Rescue Service. I should add also that events in this disaster emphasized the need for an efficient mobile scientific service for the prompt analysis of samples of mine atmospheres and the interpretation of the results of analyses—particularly where fires have developed—during the actual progress of rescue and recovery operations. This scientific service should also be based on or co-ordinated with the Mines Rescue Service.

ON THE RESCUE OPERATIONS

45. As expected, those engaged in the rescue and recovery operations upheld the high traditions established by the men in the mining industry in these activities. Calamity is indeed man's true touchstone. I should like to record my tribute to the excellent work done by all concerned under very difficult and trying conditions over the long period from the occurrence of the explosion to the recovery of the bodies of the unfortunate victims. It was unfortunate that none of the trapped men was rescued alive, but that was in no way the fault of the representatives of officials and workmen, the National Fire Service, the Mines Rescue Brigades or H.M. Inspectors who took part in the operations.

46. I feel a special word of praise should be given to the members of the National Fire Service who, for the first time in their short history and, I believe, in the annals of mining, played a valuable part in the fire-fighting operations underground. Although intended and trained for fire-fighting on the surface, the teams concerned never hesitated for a moment when they knew the fire was down in the workings of the mine.

47. Although, as I have said, all concerned in the rescue operations are worthy of praise, I have no hesitation in singling out the overman, David Brown, for special mention. His efforts to reach the trapped men in the early stages of the disaster, with and without self-contained breathing apparatus, alone and in company and as leader of a trained rescue team, were deserving of the highest praise. In all, he made no fewer than five attempts to reach the entombed men. He was indefatigable; he displayed exceptional courage and determination, well knowing the danger involved, and I have already brought this to your notice with a view to its appropriate recognition.

ON THE ADEQUACY OF THE PRECAUTIONS TAKEN TO SAFEGUARD AGAINST DANGER FROM INFLAMMABLE GAS

48. As we have seen, the possibility of the occurrence of inflammable gas in the face workings at Burngrange was recognized and certain precautions were in fact taken to safeguard against possible danger from such occurrences. Briefly, these safeguards were that facemen in charge of places should use

safety electric cap lamps, that a flame safety lamp should be kept in each working place and that before the commencement of work in a shift and before and after shot-firing, the faceman in charge should examine his place for gas. These precautions were in addition to the statutory examinations for gas with flame safety lamps by the firemen under Sections 64 and 65 of the Coal Mines Act, 1911. When the additional precautions were first published and instituted at the mine, it was also a requirement that each place should be examined for gas before the re-commencement of work following any cessation of work during the shift. It appears that in due course the original typed notice posted at the mine became defaced, and in re-typing it, this particular rule was not included. Nevertheless, it was stated in evidence that the practice of examining a place for gas during a shift following a cessation of work, such as a meal-time, was in fact carried out. Indeed, James Todd, at the actual time of the explosion, had first entered his working place for this very purpose and would have carried it out but for the fact that he was so surprised by the effects of "weighting" on the roof supports in his place that he called Reid up to see the destruction wrought. But for this fortuitous and unfortunate circumstance, this tragic disaster might have been avoided. It is sad to think that on such a small matter, the fate of so many lives depended.

49. The questions arise as to whether these precautions were adequate and, in particular, why naked lights were permitted to be used at working places adjacent to goaf or waste, having regard to the potential danger of inflammable gas being quickly expelled from wastes in dangerous quantity. It must be borne in mind, however, from the evidence at the Inquiry and from an examination of the records of the mine, that inflammable gas had previously been found very infrequently and in small quantity in narrow places usually being driven to the rise and that the potential danger of gas suddenly expelled from waste or goaf only became apparent as a result of this disaster, a disaster unparalleled in the annals of oil shale mining.

50. Nevertheless, it is clear and recognized by all concerned, that the precautions in use prior to the disaster are insufficient. Indeed, the very fact of the explosion means that the provisions of Section 32 of the Coal Mines Act, 1911, must now be implemented. Among these provisions is one which requires that "no lamp or light other than a locked safety lamp shall be allowed or used in any seam (except in the main intake airways within 200 yards of the shaft) in which an explosion of inflammable gas causing any personal injury whatever has occurred within the previous twelve months unless exemption is granted on account of the special character of the mine. I am of the opinion that only locked safety lamps should be permitted within prescribed areas to include all working faces, but I am satisfied that exemption from the use of safety lamps is warranted by the character of the mine for those parts of it outside these areas.

51. When discussing the precautions to be taken to prevent the recurrence of a similar disaster, the question of blasting must also be considered. By virtue of Section 1, the provisions of the Coal Mines Act, 1911, apply to oil shale mines. Section 61 of the Act provided for regulations governing "the supply, use and storage of any explosives at mines or any class of mines". The Order made under Section 61 of the Act is entitled "The Explosives in Coal Mines Order". This Order is in two parts. The opening words of Clause 5 (a) with which Part II of the Order begins, read as follows :—

"In all coal mines in which inflammable gas has been found within the previous three months in such quantities as to be indicative of danger, no explosive, other than a permitted explosive as hereinafter defined shall be used"

52. It is clear, therefore, that Part II of the Order specifically applies to coal mines and not to any other class of mines.

53. So far as Part I of the Order is concerned, there seems no doubt that it was intended to apply to all mines to which the Act applies but it does not contain any clear and specific provision to that effect, and as it is entitled "The Explosives in Coal Mines Order", the position is not free from ambiguity. In fact, the owners of oil shale mines have always been of the opinion that the Order is not applicable.

54. Be that as it may, Part I of the Order is generally appropriate to oil shale mines, but to apply Part II would undoubtedly entail serious difficulties and some anomalies. It is obviously desirable, however, that the use of explosives in oil shale mines under all circumstances should be regulated. To clarify the position I am of the opinion that a separate Order under Section 61 of the Act should be made for this purpose.

55. Bearing in mind that the workings in oil shale mines in general are relatively free from inflammable gas and also that permitted explosives have recognized limitations in the blasting of oil shale, the requirements of the proposed new Order need not go so far as those in Part II of the existing Order applicable to coal mines; but, in the light of this particular disaster, I would recommend that in those seams or parts of seams of oil shale where safety lamps are required, the proposed Order should make the use of permitted explosive compulsory in all places in direct contact with, or about to hole through on, waste or goaf.

56. It will, of course, be necessary for the manager to appoint in writing competent persons to fire shots where permitted explosives are used. But in the case of oil shale mines, where the system of working is Stoop and Room and where most of the shots are fired just before meal-time, I do not consider it necessary or advisable for the choice of such competent persons to be confined to those whose wages do not depend upon the amount of mineral to be gotten. In such circumstances, to confine shot-firing in a district to one shot-firer must inevitably tend to the "bunching" of shot-firing within a very limited period around the meal-time and to the consequent neglect of the proper examinations and other precautions to be taken before shot-firing. I see no reason why, under proper safeguards, a properly trained and experienced shale miner who has charge of a working place or places should not be competent to fire shots where permitted explosives are used, and I recommend that provision be made accordingly in the proposed Order.

CONCLUSIONS

57. Summarizing the results of the Inquiry, I consider it established—

(1) That the initial firedamp explosion originated near the waste edge close to the face of the rise split off No. 14 Level, one of James Todd's working places in the stooping section, No. 2 District, Dunnet Seam, when firedamp was ignited at the flame of the open acetylene cap lamp carried by Thomas Reid.

(2) That the initial explosion was followed almost immediately by a second firedamp explosion, which spread along the waste to adjacent places and that this explosion was followed by a series of lighter explosions and the burning of gas along the waste edge, causing flame to persist.

(3) That the firedamp had collected gradually over a period of time in the higher cavities of the waste or goaf formed by the stooping, where its presence could not normally be detected, and that some of it had been expelled therefrom into Todd's working place by roof movements or falls of roof in the waste shortly before the return of the workmen after their meal interval.

(4) That the persistent flame caused fires in at least five separate places, due initially to the ignition of timber at or near the waste edge and the subsequent ignition of fallen or loose pieces of oil shale.

(5) That these fires were sufficiently brought under control to permit of rescue operations but were not wholly extinguished, largely due to inaccessibility, with the result that the fire area had to be sealed off.

(6) That John McGarty was fatally injured through his head striking a sharp object when he was blown down by the blast from the second explosion and that the 14 other men lost their lives from the effects of breathing afterdamp produced by the explosions and subsequent fires.

(7) That there were no breaches of statutory requirements.

RECOMMENDATIONS

58. The Inquiry has disclosed that it is necessary and desirable to effect certain changes and I make the following recommendations :—

(1) That only locked safety lamps be permitted within prescribed areas to include all working faces in the Dunnet Seam but that exemption from the full requirements of Section 32 of the Coal Mines Act, 1911, is warranted by the character of the mine in respect of those parts outwith the prescribed areas.

(2) That since there is some ambiguity as to the application of the Explosives in Coal Mines Order and some difficulty in applying it to oil shale mines, the use of explosives in such mines should be governed by a separate Order under Section 61 of the Coal Mines Act, 1911.

(3) That by this Order any seam or part of a seam in mines of oil shale in which safety lamps are required by the Act or Regulations of the mine to be used, the use of permitted explosives should be made compulsory in all working places in direct contact with, or about to hole through on, waste or goaf.

(4) That properly trained and experienced oil shale miners in charge of a working place or places, should be eligible for appointment as competent persons to fire shots where permitted explosives are used, notwithstanding that their wages depend upon the amount of mineral gotten.

(5) That, whilst it would be unreasonable to prohibit by Regulation the practice of "stooping" elsewhere than at the return end of a ventilating district, or, in other words, to require that the air used for ventilating a "stooping" section, shall not thereafter be used for the ventilation of other workings, nevertheless this practice should be resorted to only in special or exceptional circumstances.

(6) That in each geographical Division of the National Coal Board there should be (a) a first-class common fire-fighting service, and (b) an efficient mobile scientific service for the prompt analysis of samples of mine atmospheres and the interpretation of results of analyses, for mines of all classes, whether operated by the National Coal Board or not, based on or co-ordinated with a common and efficient Mines Rescue Service.

59. Finally, I desire to express my sincere thanks to the representatives of the parties who appeared at the Investigation and to Mr. Offord, Clerk of Court, for the valuable help and assistance they gave me at the Inquiry. Because of their whole-hearted co-operation, it was possible to complete the Inquiry in two days.

I have the honour to be, Sir,

Your obedient Servant,

A. M. BRYAN.

APPENDIX I

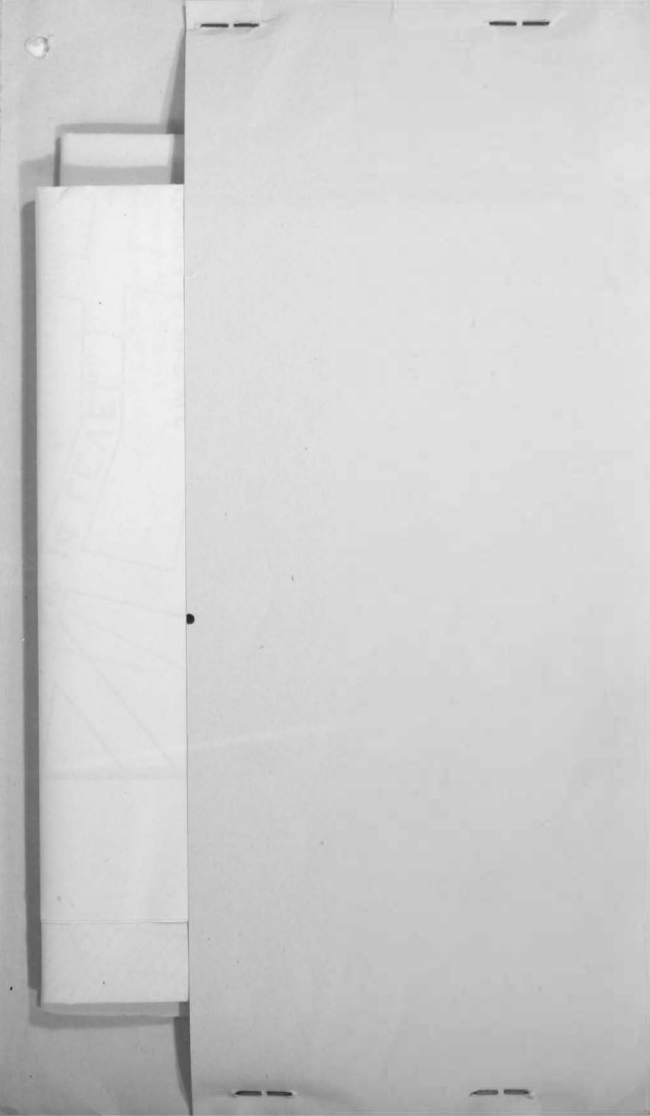
LIST OF WITNESSES

<i>Name</i>	<i>Occupation</i>
1. Harold Verdon Thwaites ..	Medical Practitioner.
2. William Clark Sharp ..	Regional Mines Medical Officer.
3. Roderick McLean ..	Surveyor.
4. James Todd ..	Faceman.
5. Thomas Reid ..	Miner's Drawer.
6. Andrew Johnstone ..	Faceman.
7. Pat McGirl ..	Miner's Drawer.
8. Thomas Davidson ..	Miner's Drawer.
9. Thomas Haston ..	Faceman.
10. George Pettigrew ..	Miner's Drawer.
11. Robert Miller ..	Faceman.
12. John Forrester ..	Miner's Drawer.
13. Robert Reid ..	Faceman.
14. William Kerr ..	Miner's Drawer.
15. Alexander Todd ..	Bencher.
16. James Mitchell ..	Motorman.
17. George Crombie ..	Fireman.
18. David Brown ..	Overman.
19. James McArthur ..	Faceman, Workmen's Inspector and Rescue Worker.
20. John Brownlie McArthur ..	Manager.
21. Archibald Gibb Russell ..	Undermanager.
22. John Stein ..	Mine Agent.
23. David Davidson ..	Rescue Station Superintendent.
24. Bryce Anderson ..	Company Officer, National Fire Service.
25. William Bell Muir ..	Fire Force Commander, National Fire Service.
26. James Readdie ..	Captain of Rescue Brigade.
27. John Girdwood ..	Fireman.
28. John McBeth ..	Fireman.
29. Joseph Kinsman ..	Workmen's Inspector
30. William Hislop ..	H.M. Assistant Inspector of Mines.
31. Thomas Arthur Rogers ..	H.M. District Inspector of Mines.

APPENDIX II

PARTICULARS OF PERSONS KILLED

<i>Name</i>	<i>Age</i>	<i>Occupation</i>	<i>Nature of Injuries</i>
1. John McGarty ..	30	Miner's Drawer ..	Fractured skull.
2. Thomas Heggie ..	27	Miner ..	Carbon monoxide poisoning.
3. Henry Cowie ..	36	Miner's Drawer ..	Carbon monoxide poisoning.
4. John Lightbody ..	41	Miner ..	Carbon monoxide poisoning.
5. David Carroll ..	36	Miner's Drawer ..	Carbon monoxide poisoning.
6. William Carroll ..	31	Miner's Drawer ..	Carbon monoxide poisoning.
7. William Greenock ..	51	Miner ..	Carbon monoxide poisoning.
8. James McAuley ..	59	Miner ..	Carbon monoxide poisoning.
9. David Muir ..	25	Miner's Drawer ..	Carbon monoxide poisoning.
10. Anthony Gaughan ..	45	Miner ..	Carbon monoxide poisoning.
11. William Ritchie ..	39	Miner ..	Carbon monoxide poisoning and burns.
12. John Fairley ..	20	Miner's Drawer ..	Carbon monoxide poisoning.
13. Samuel Pake ..	24	Miner's Drawer ..	Carbon monoxide poisoning.
14. William Findlay ..	56	Oncost Worker	Carbon monoxide poisoning and burns.
15. George Easton ..	53	Oncost Worker	Carbon monoxide poisoning.



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